

NASA Contractor Report 4379

N-91
19997
P-32

Supplement to Photographic Catalog of Selected Planetary Size Comparisons

Stephen Paul Meszaros

GRANT NAGW-2102

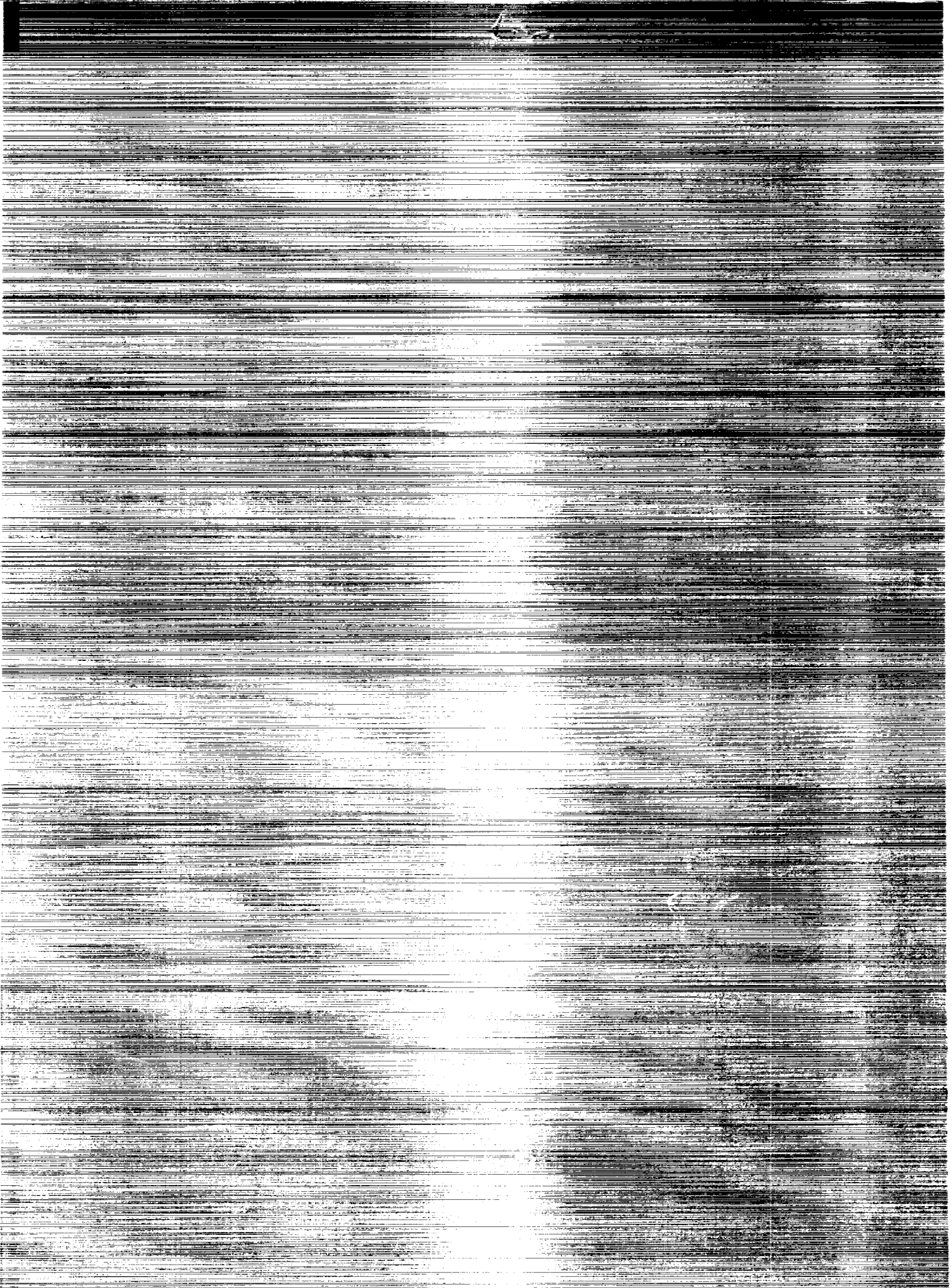
JUNE 1991

(NASA-CR-4379) SUPPLEMENT TO PHOTOGRAPHIC
CATALOG OF SELECTED PLANETARY SIZE
COMPARISONS (Arizona State Univ.)

32 p
CSCL 038

N91-26100

Unclas
H1/91 001997



NASA Contractor Report 4379

Supplement to Photographic Catalog of Selected Planetary Size Comparisons

Stephen Paul Meszaros
Arizona State University
Tempe, Arizona

Prepared for
NASA Office of Planetary Geosciences
under Grant NAGW-2102



National Aeronautics and
Space Administration

Office of Management

Scientific and Technical
Information Program

1991

SUPPLEMENT TO: PHOTOGRAPHIC CATALOG OF SELECTED PLANETARY SIZE COMPARISONS

by

Stephen Paul Meszaros

ABSTRACT

This document updates and extends the NASA Technical Memorandum 86207, "Photographic Catalog of Selected Planetary Size Comparisons," 1985. It utilizes photographs taken by NASA spacecraft to illustrate size comparisons of planets and moons of the solar system. Global views are depicted at the same scale, within each comparison, allowing size relationships to be studied visually.

CONTENTS

	Page
Abstract	iii
Author's Note	vii
Introduction	ix
Part I: Photograph Captions	1
Part II: Photographic Comparisons	9
Suggested Reading	27

AUTHOR'S NOTE

This publication may be considered as a supplement to a previously published NASA technical memorandum entitled "Photographic Catalog of Selected Planetary Size Comparisons." It updates the solar system coverage resulting from the Voyager spacecraft encounters with Uranus and Neptune in 1986 and 1989 respectively. Those readers interested in obtaining the original "Photographic Catalog" should consult the Suggested Reading list at the end of this document.

The author would appreciate any comments and suggestions (or questions) concerning the visuals presented here. Contact:

Stephen P. Meszaros
U.S. Department of the Interior
Bureau of Land Management
3707 N. 7th Street
Phoenix, Arizona 85014

SUPPLEMENT TO : PHOTOGRAPHIC CATALOG OF SELECTED PLANETARY SIZE COMPARISONS

INTRODUCTION

Over the past three decades NASA spacecraft have visited many of the planets and moons of the solar system. Out of these missions has come a wealth of scientific data and detailed photographs. Accurate size measurements of the planets and moons, and their surface features, is one of the most basic types of information to result from this exploration program.

The photographs presented in this publication show planet and moon global views at the same scale, within each picture. This will allow size relationships to be studied visually. Generally, original spacecraft photos were used. However, when this was not feasible because of availability factors, line drawings were substituted.

The publication is divided into two main parts. Part I contains the picture captions while Part II contains the pictures. The picture captions and pictures are similarly numbered. Thus, caption number 1 explains picture number 1, caption number 10 explains picture number 10, etc. The "Suggested Reading" section lists books that were selected especially for their lucid descriptions and/or their photographic content.

All the illustrations in this publication are available for purchase (as photo prints, slides, vu-graphs, etc.) using the "H" or "HC" number designation included with each picture. ("H" indicates that the picture is available in black and white, "HC" indicates that it is available in color. Some pictures are available both ways.) For information, write:

Broadcast and Audio-Visual Branch
Code PMD
National Aeronautics and Space Administration
400 Maryland Avenue, SW
Washington, D.C. 20546

Educators and scientists may also obtain photo products from the National Space Science Data Center. For information, contact:

National Space Science Data Center
Code 933
Goddard Space Flight Center
Greenbelt, Maryland 20771

In addition, the U.S. Geological Survey has produced a large number of maps, at global and larger scales, of many of the planets and moons in the solar system. For information and a list of the maps available, write:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092

Part I

PHOTOGRAPH CAPTIONS

GIANT PLANETS

Photo 1

90 H 592
90 HC 544

The solar system's four largest planets are compared with the Earth in this photomontage. These giant worlds are composed primarily of hydrogen and helium with lesser amounts of ammonia, methane, and other gases. Various chemical compounds in the upper atmospheres account for the colors present. These photographs of the gas giant worlds were taken by the Voyager 1 and Voyager 2 spacecraft.

Diameters

Jupiter	142,984 kilometers	(88,850 miles)
Saturn	120,536 kilometers	(74,901 miles)
Uranus	51,118 kilometers	(31,765 miles)
Neptune	49,528 kilometers	(30,777 miles)
Earth	12,756 kilometers	(7,927 miles)

LARGE PLANETS

Photo 2

90 H 593
90 HC 545

The solar system's two outermost gas giant planets are compared with the Earth in this photomontage. Their atmospheres are composed primarily of hydrogen and helium; the blue colors are due to methane, which is also present. In size, Uranus has a diameter of 51,118 kilometers (31,765 miles), while Neptune's diameter is 49,528 kilometers (30,777 miles). For comparison, the Earth is 12,756 kilometers (7,927 miles) in diameter. The photographs of Uranus and Neptune were taken by the Voyager 2 spacecraft.

PLANETS AND MOONS

Photo 3

90 H 594
90 HC 546

This montage of photographs taken by various NASA spacecraft displays the smaller planets and larger moons of the solar system at the same scale. The inner planets Mercury, Venus, Earth, Mars, and the Earth's moon are shown, as well as Jupiter's large satellites Io, Europa, Ganymede, and Callisto, Saturn's large moon Titan, and Neptune's large moon Triton. In the case of the Earth and Mars we are looking through relatively thin atmospheres to the surfaces below. Venus and Titan have deep atmospheres so only their cloud tops are visible. Mercury, the Earth's moon, Io, Europa, Ganymede, Callisto, and Triton have little or no atmospheres, so their varied surface features can be seen directly.

Diameters

Earth	12,756 kilometers	(7,927 miles)
Venus	12,102 kilometers	(7,520 miles)
Mars	6,786 kilometers	(4,217 miles)
Mercury	4,878 kilometers	(3,031 miles)
Moon	3,476 kilometers	(2,160 miles)
Io	3,630 kilometers	(2,256 miles)
Europa	3,138 kilometers	(1,950 miles)
Ganymede	5,262 kilometers	(3,270 miles)
Callisto	4,800 kilometers	(2,983 miles)
Titan	5,150 kilometers	(3,200 miles)
Triton	2,700 kilometers	(1,678 miles)

LARGE MOONS

Photo 4

90 H 595
90 HC 547

The largest moons of the solar system are shown in this photomontage. Earth's moon is located in the center. Io, Europa, Ganymede, and Callisto are satellites of Jupiter; Titan is a satellite of Saturn; Triton is a satellite of Neptune. Titan has a deep atmosphere; consequently, that is all that is visible. The rest of the moons have little or no atmospheres, so their varied surface features can be viewed directly. These photographs--with the exception of the moon--were taken by the Voyager spacecraft.

Diameters

Moon	3,476 kilometers	(2,160 miles)
Io	3,630 kilometers	(2,256 miles)
Europa	3,138 kilometers	(1,950 miles)
Ganymede	5,262 kilometers	(3,270 miles)
Callisto	4,800 kilometers	(2,983 miles)
Titan	5,150 kilometers	(3,200 miles)
Triton	2,700 kilometers	(1,678 miles)

MOONS OF SATURN AND URANUS #1

Photo 5

88 H 371

The medium-sized moons of Saturn and Uranus are shown at the same scale in this photomontage. These photographs were taken by the Voyager spacecraft.

Diameters

Mimas	390 kilometers	(242 miles)
Enceladus	500 kilometers	(311 miles)
Tethys	1,050 kilometers	(653 miles)
Dione	1,120 kilometers	(696 miles)
Rhea	1,530 kilometers	(951 miles)
Iapetus	1,440 kilometres	(895 miles)
Miranda	470 kilometers	(292 miles)
Ariel	1,160 kilometers	(721 miles)
Umbriel	1,170 kilometers	(727 miles)
Titania	1,580 kilometers	(982 miles)
Oberon	1,520 kilometers	(945 miles)

MOONS OF SATURN AND URANUS #2

Photo 6

88 H 372

The medium-sized moons of Saturn and Uranus are shown at the same scale as Earth's moon in this photomontage. They range in size from Mimas the smallest (diameter: 390 kilometers or 242 miles) to Titania the largest (diameter: 1,580 kilometers or 982 miles). The Earth's moon has a diameter of 3,476 kilometers or 2,160 miles (photograph of Earth's moon courtesy of Lick Observatory).

MOONS OF URANUS

Photo 7

88 H 370

The five larger moons of Uranus are shown at the same scale as Earth's moon in this photomontage. In composition they are made of rock and ice (photograph of Earth's moon courtesy of Lick Observatory).

Diameters

Moon	3,476 kilometers	(2,160 miles)
Miranda	470 kilometers	(292 miles)
Ariel	1,160 kilometers	(721 miles)
Umbriel	1,170 kilometers	(727 miles)
Titania	1,580 kilometers	(982 miles)
Oberon	1,520 kilometers	(945 miles)

SMALL MOON COMPARISONS

Photo 8

90 H 601

The outlines of some of the smaller moons of Jupiter, Saturn, Uranus, and Neptune are pictured here at the same scale. They are generally irregular in shape since their gravities are too weak to pull them into spheres. For comparison, the Island of Hawaii is also shown at the same scale.

URANUS AND EARTH

Photo 9

88 H 374

Uranus is one of the smaller gas giant planets. Yet it is still four times the size of the Earth. The diameter of Uranus is 51,118 kilometers (31,765 miles), compared to Earth's 12,756 kilometers (7,927 miles) diameter. Its bland atmosphere is essentially featureless.

NEPTUNE AND EARTH

Photo 10

90 H 597

Neptune is the most distant of the gas giant planets from the sun. Its diameter is 49,528 kilometers (30,777 miles). This compares with Earth's diameter of 12,756 kilometers (7,927 miles). One of the gases in Neptune's atmosphere--methane--gives it a very blue appearance.

TRITON AND THE MOON

Photo 11

90 H 598

Triton is the largest moon of Neptune. Its diameter is 2,700 kilometers (1,678 miles); for comparison the Earth's moon has a diameter of 3,476 kilometers (2,160 miles). Because of its great distance from the sun, Triton experiences very cold temperatures resulting in ice caps of frozen nitrogen. It also has dozens of geysers. At any one time a number of these may be active, propelling nitrogen gas several kilometers (miles) above Triton's surface.

THE MOON AND THE PLUTO-CHARON SYSTEM

Photo 12

90 H 599

This illustration shows the relative sizes of the Earth's moon, the planet Pluto, and Pluto's satellite Charon. Also shown to the same scale is the Pluto-Charon orbital distance. Since there has not yet been a spacecraft mission to Pluto and Charon, we have no detailed photographs of this system (Pluto appears only as a point of light, even in the largest Earth-based telescopes). The estimated diameter of Pluto is 2,300 kilometers (1,429 miles); Charon's estimated diameter is 1,190 kilometers (740 miles). For comparison, the moon's diameter is 3,476 kilometers (2,160 miles).

ENCELADUS AND MIRANDA

Photo 13

88 H 373

Enceladus, a moon of Saturn, is compared in size with Miranda, a moon of Uranus. Enceladus has a diameter of 500 kilometers (311 miles), while the diameter of Miranda is 470 kilometers (292 miles). These two moons are of special interest to space scientists because of their unusual surface features. Parts of Enceladus have very few craters, indicating recent resurfacing from the interior of the moon. This may be the result of ice volcanism, which could also explain the high albedo (reflected brightness) of Enceladus as well as the concentration of Saturn's E-Ring particles in Enceladus' orbit. Miranda has three visible areas of layered terrain on its surface. These may indicate that this small satellite was broken up by asteroid or comet impact in the past and has gravitationally reassembled itself. Another possibility is that the interior of Miranda was in the act of differentiating (separating) and froze before the process was complete.

NUCLEUS OF HALLEY'S COMET AND MANHATTAN ISLAND

Photo 14

88 H 375

The approximate size and shape of the nucleus of Halley's Comet is shown in this visual. Its size is estimated to be about 8 kilometers (5 miles) by 16 kilometers (10 miles). This information was obtained by the European Giotto spacecraft and the Soviet Vega spacecraft when they flew by the comet in 1986. The outline of Manhattan Island is shown at the same scale for comparison.

RINGED PLANET COMPARISONS

Photo 15

90 H 600

This diagram compares the rings of the four planets with ring systems in the solar system. The Earth is also shown at the same scale. All four ring systems are very different in character. The main rings of Saturn (designated A, B, and C) are bright and are extremely complex in structure. Jupiter's ring is apparently composed of fine particles that may be slowly spiraling down into the cloud tops of the planet. The rings of Uranus are dark and thin in nature (they are exaggerated in width, in this sketch). Neptune has both thin and wider diffuse rings.

THE GREAT DARK SPOT

Photo 16

90 H 596
90 HC 548

The Earth is shown at approximately the same scale as the Great Dark Spot of Neptune. The Dark Spot is a huge long-lived storm in Neptune's upper atmosphere.

Part II
PHOTOGRAPHIC COMPARISONS

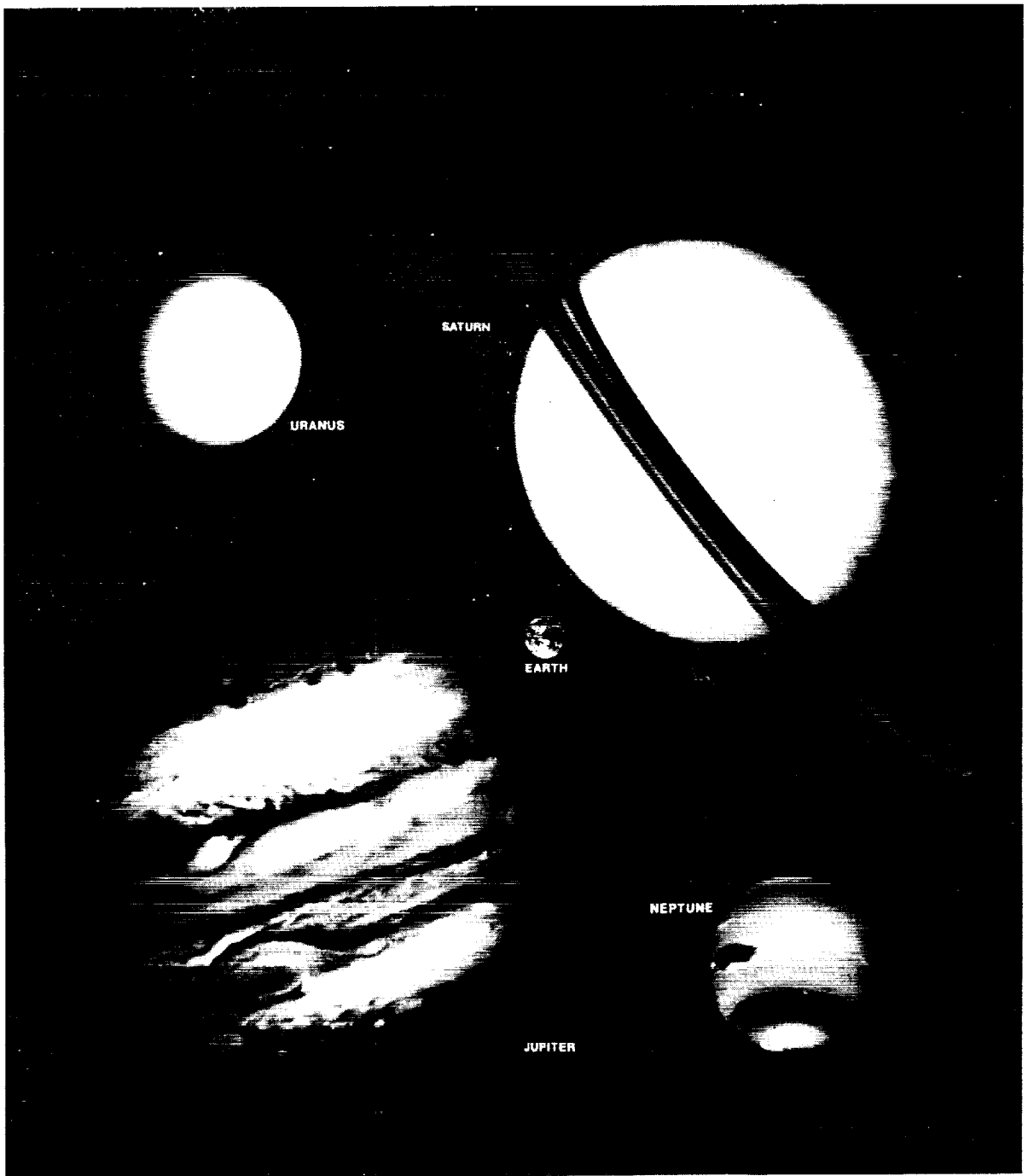


Photo 1 - GIANT PLANETS

90 H 592
90 HC 544

ORIGINAL PAGE IS
OF POOR QUALITY

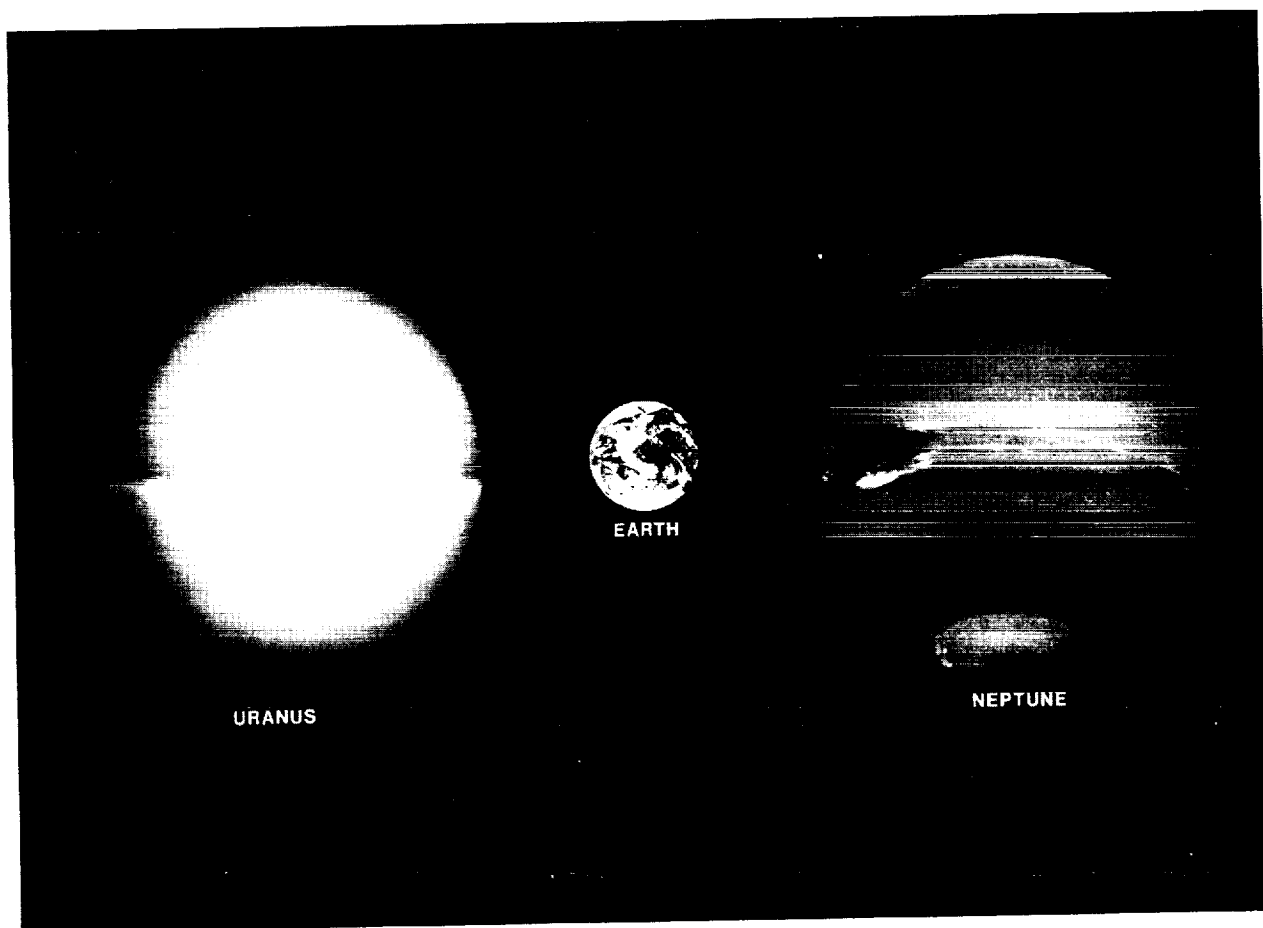


Photo 2 - LARGE PLANETS

ORIGINAL PAGE IS
OF POOR QUALITY

90 H 593
90 HC 545

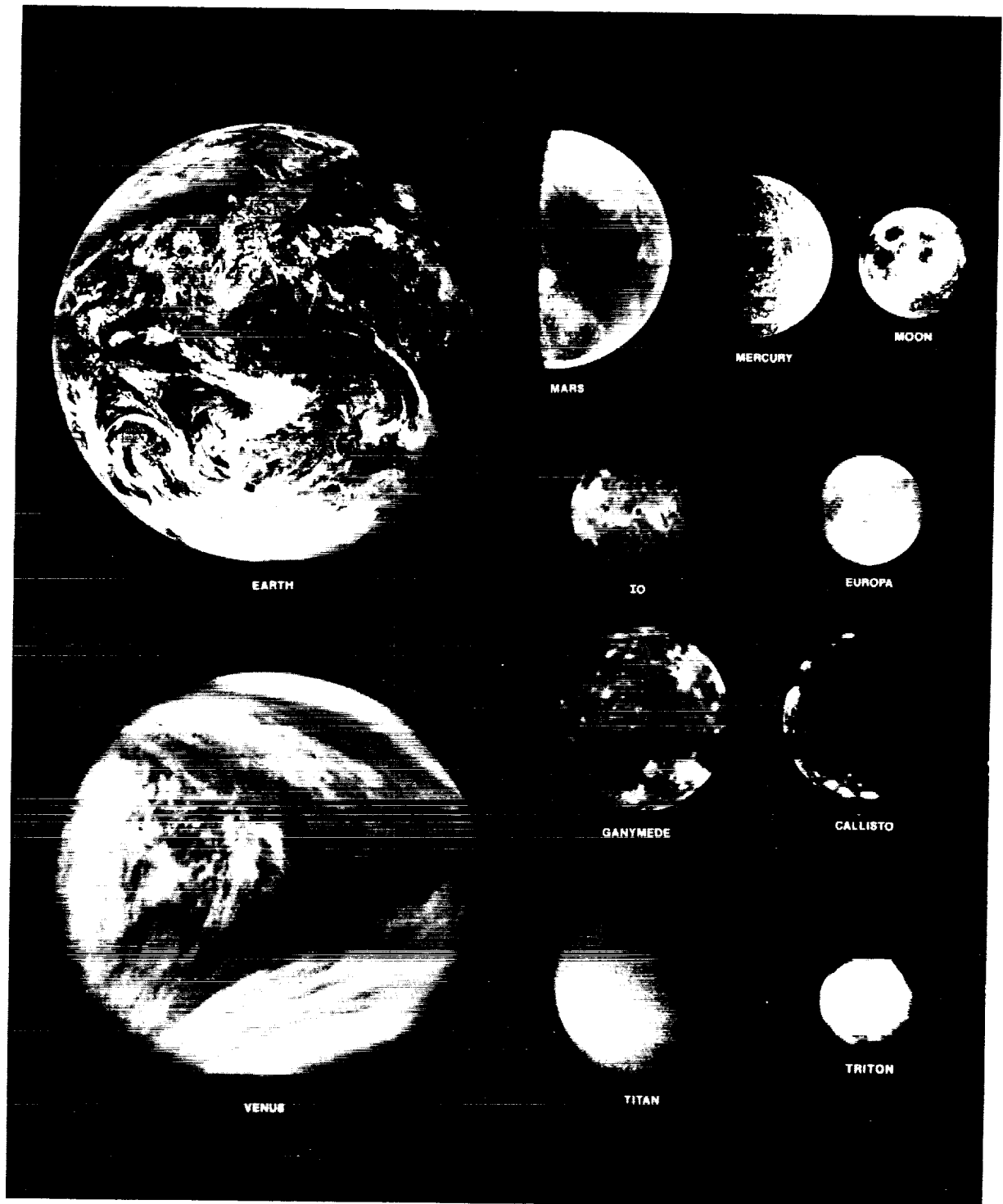


Photo 3 - PLANETS AND MOONS

90 H 594
90 HC 546

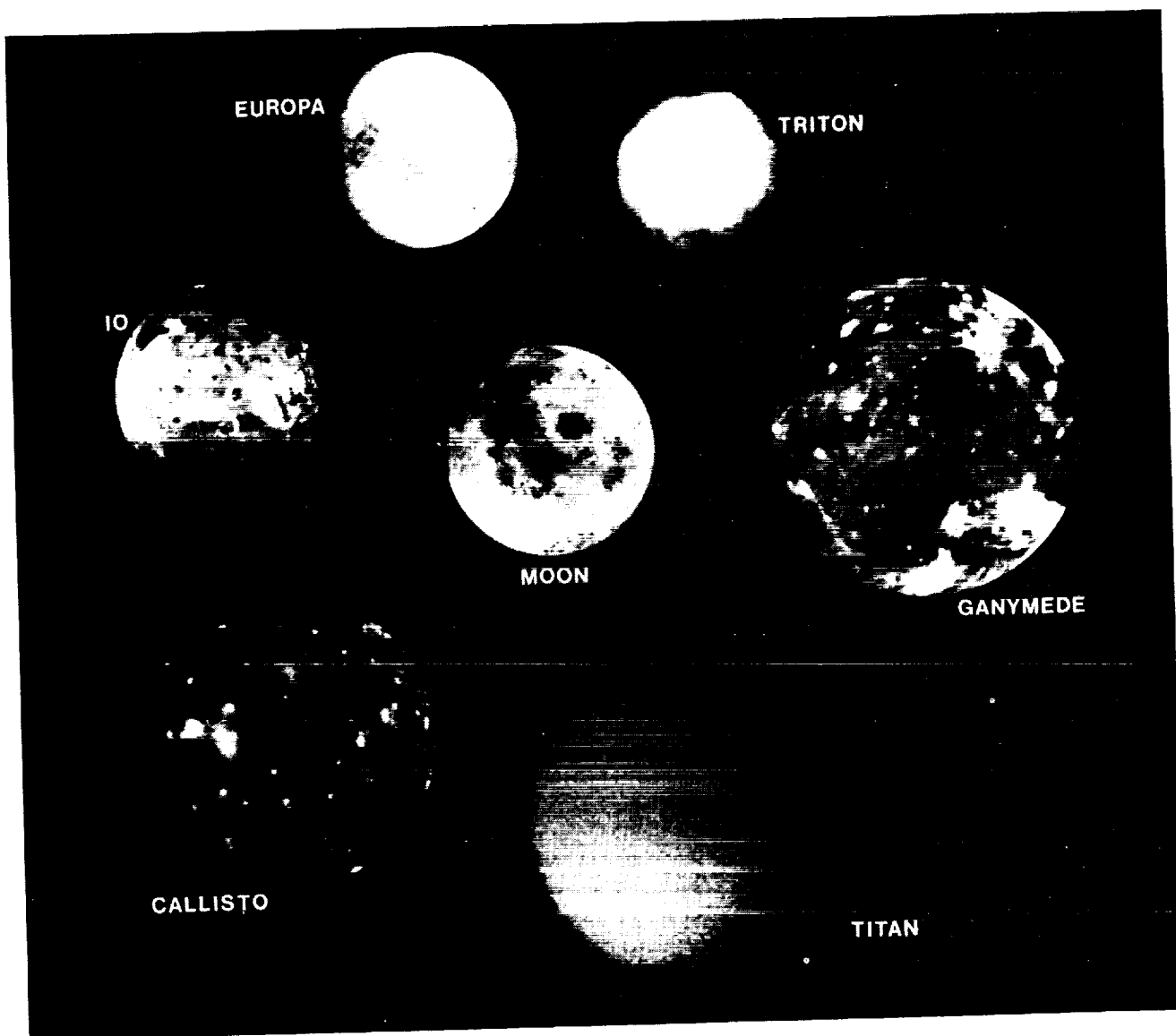


Photo 4 - LARGE MOONS

ORIGINAL PAGE IS
OF POOR QUALITY

90 H 595
90 HC 547

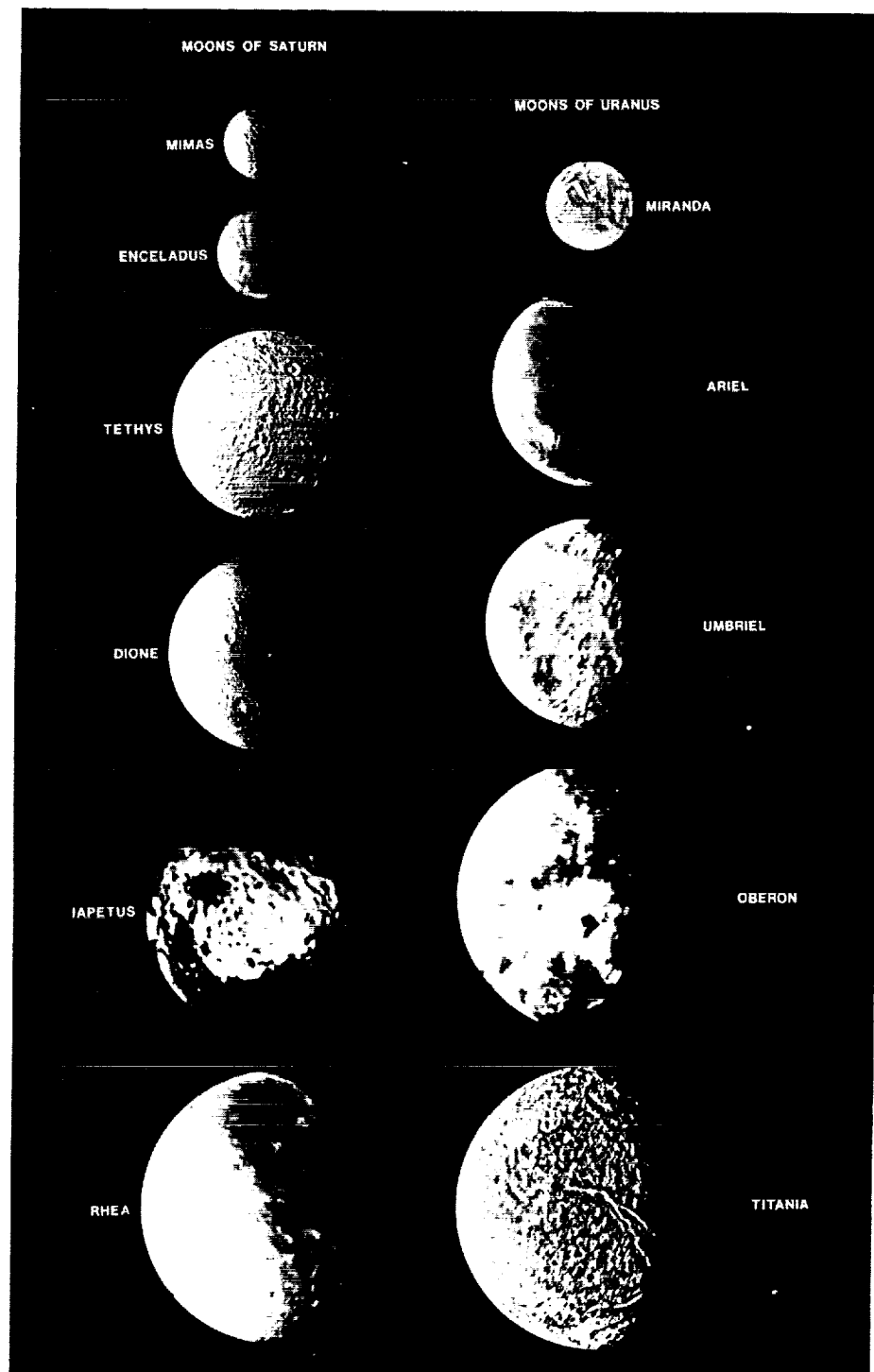


Photo 5 - MOONS OF SATURN AND URANUS #1

88 H 371

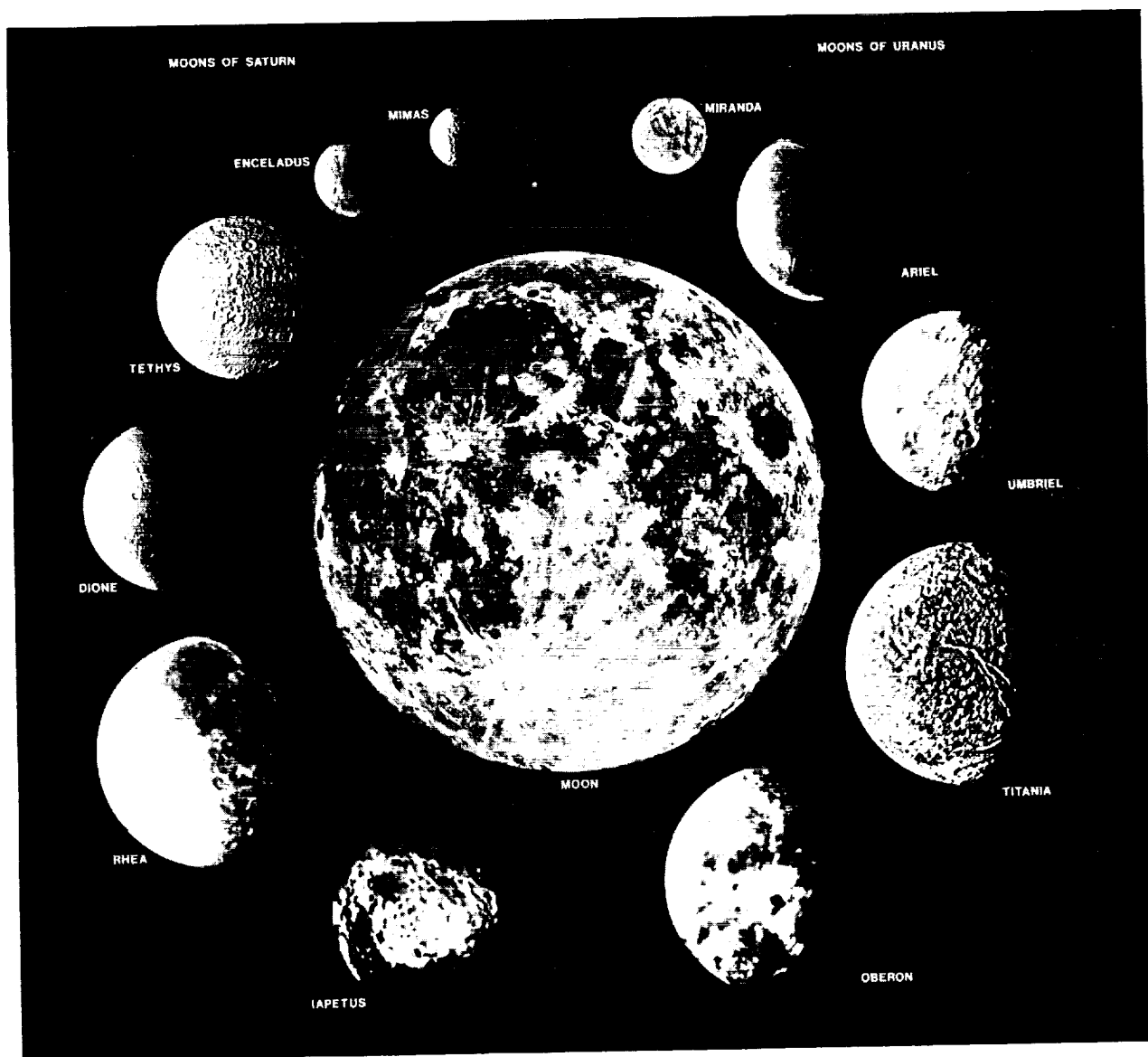


Photo 6 - MOONS OF SATURN AND URANUS #2

88 H 372

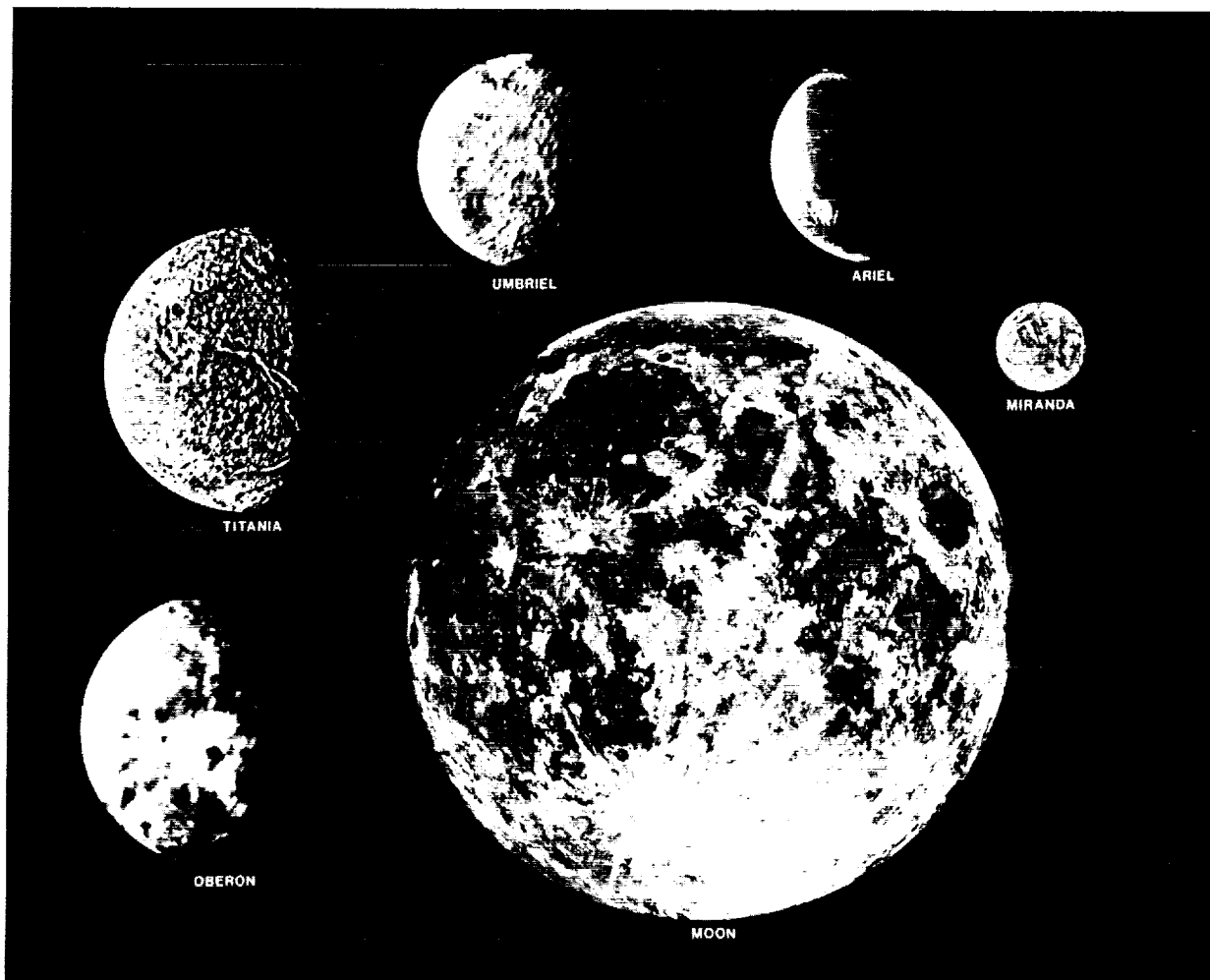


Photo 7 - MOONS OF URANUS

88 H 370

ORIGINAL PAGE IS
OF POOR QUALITY

SMALL MOON COMPARISONS

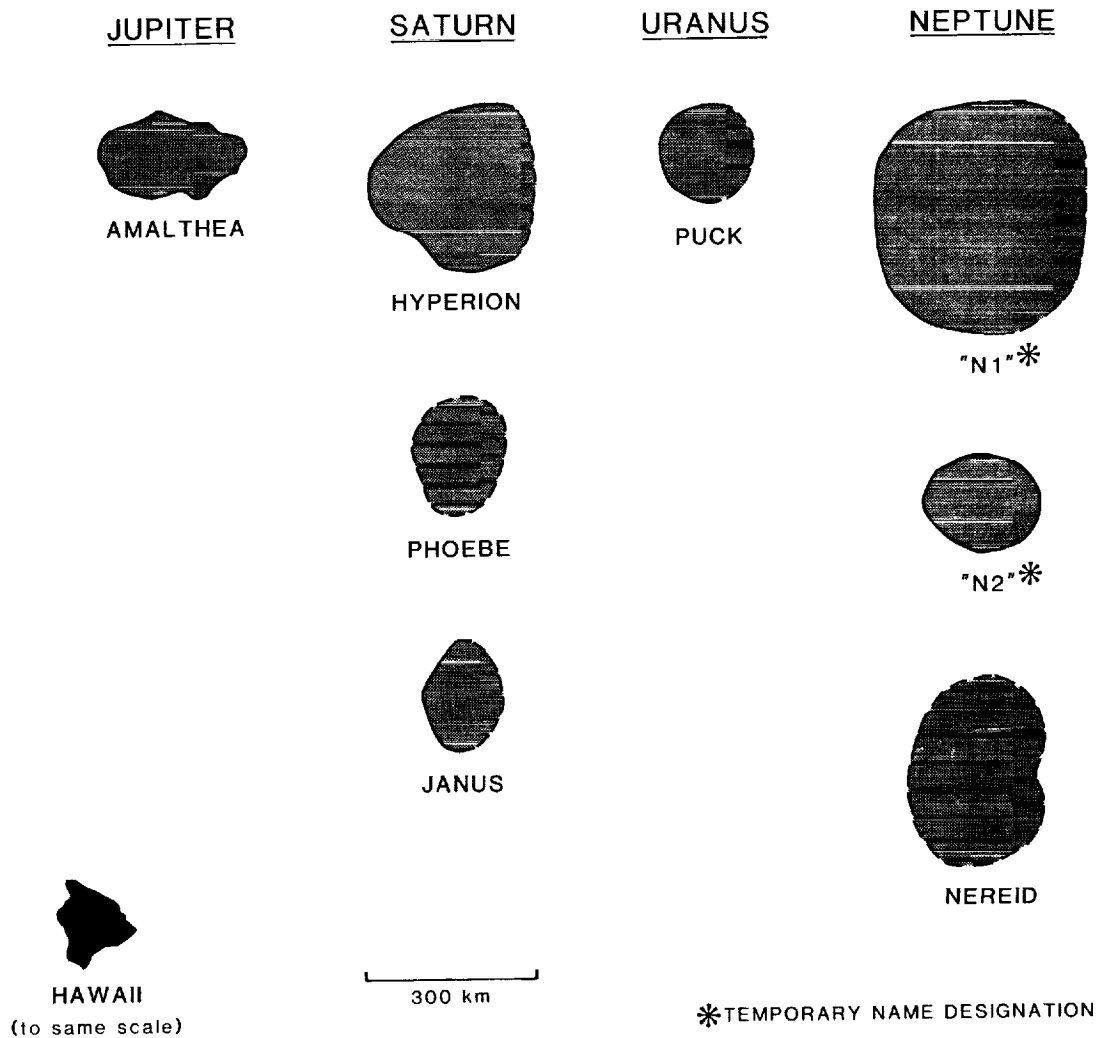


Photo 8 - SMALL MOON COMPARISONS

90 H 601

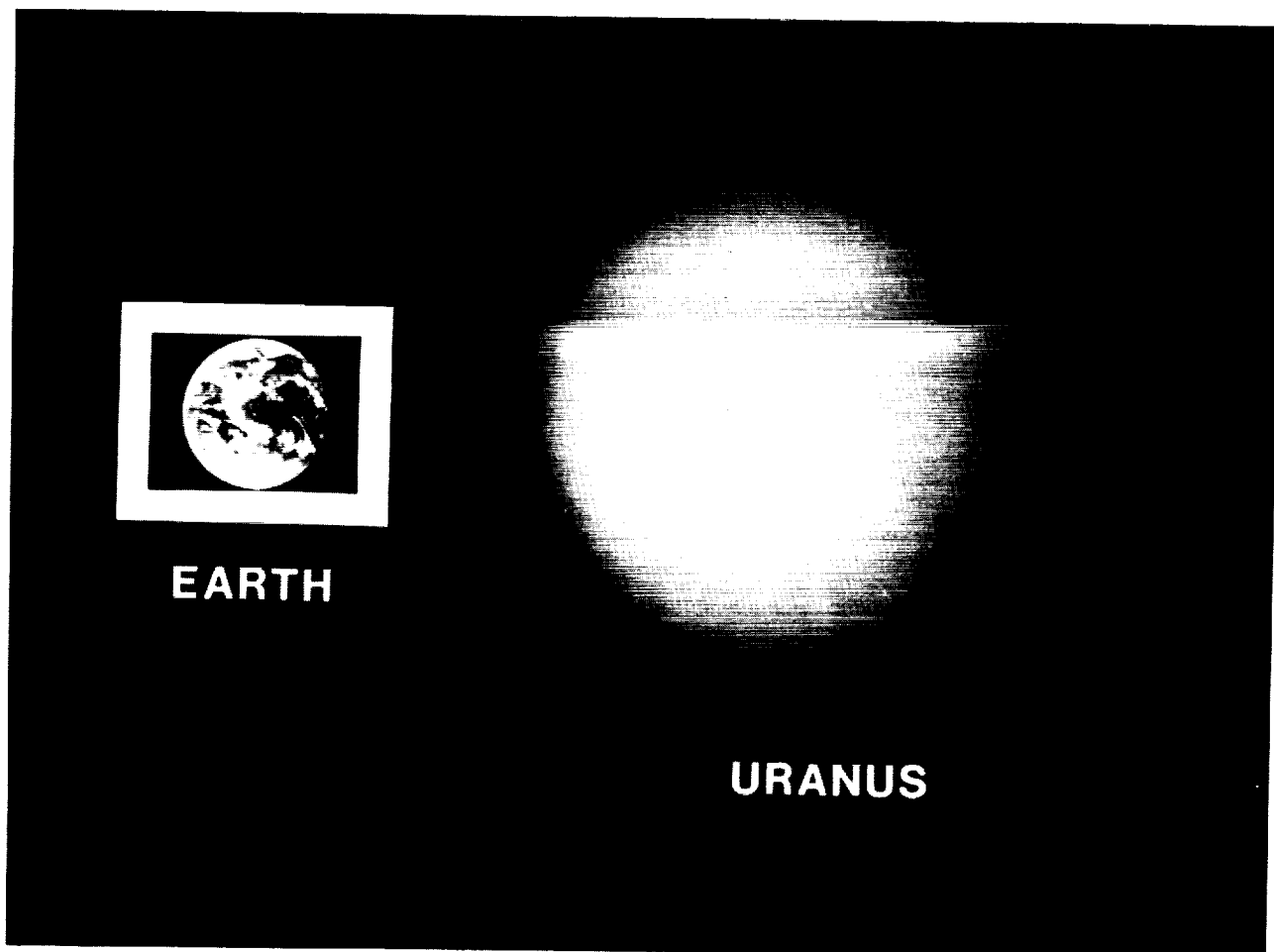


Photo 9 - URANUS AND EARTH

88 H 374

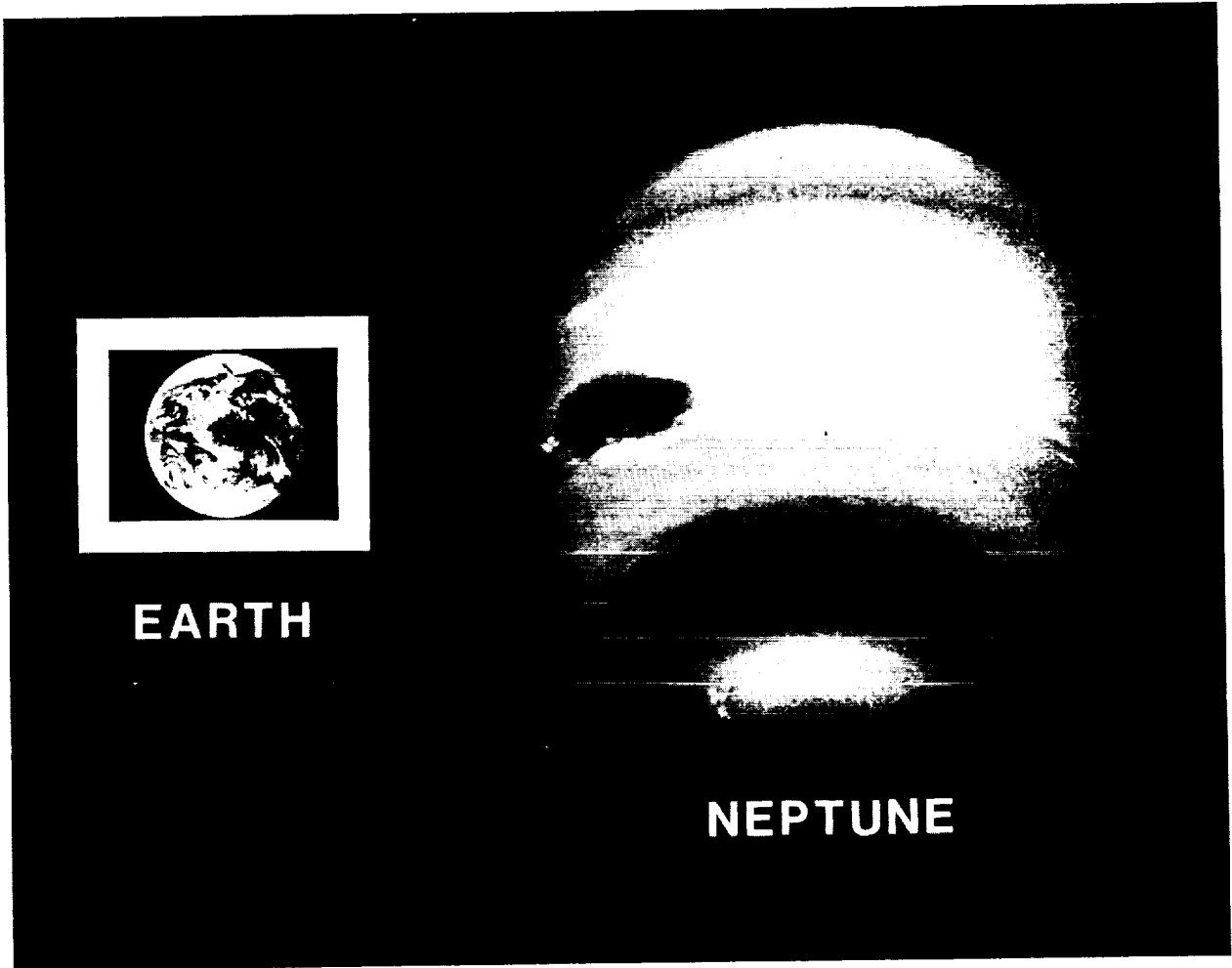


Photo 10 - NEPTUNE AND EARTH

90 H 597

ORIGINAL PAGE IS
OF POOR QUALITY

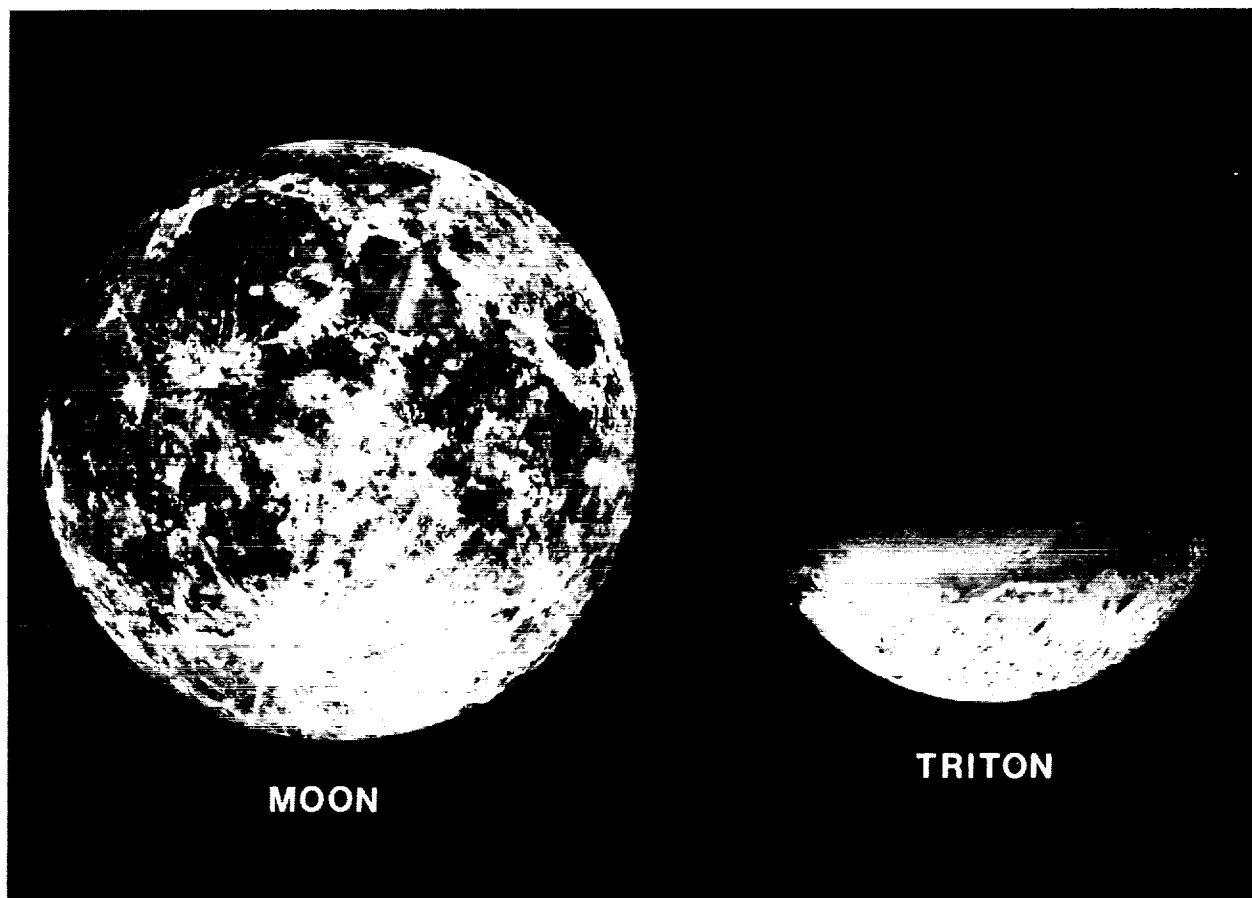


Photo 11 - TRITON AND THE MOON

90 H 598

THE MOON AND THE PLUTO - CHARON SYSTEM
(TO SCALE)

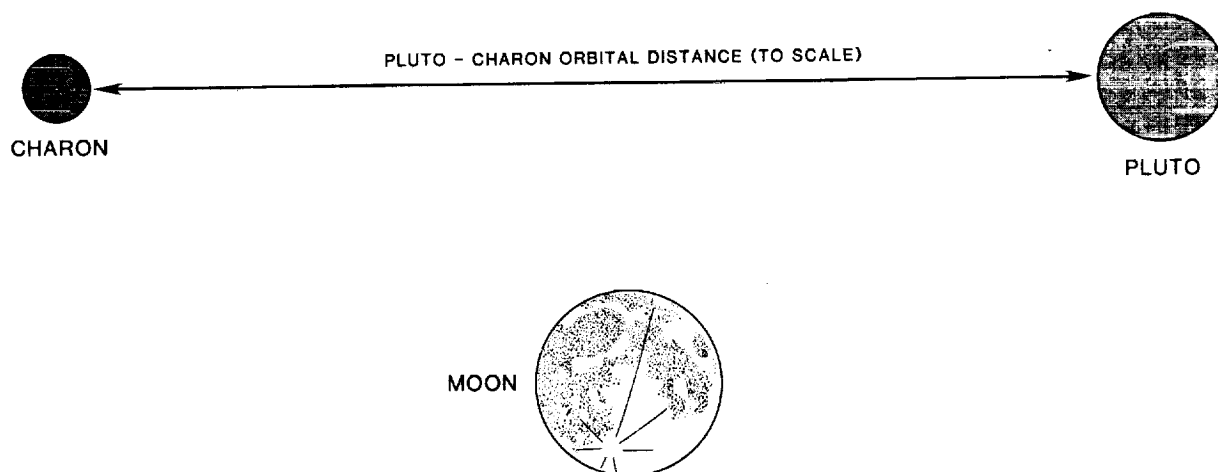


Photo 12 - THE MOON AND THE PLUTO-CHARON SYSTEM

90 H 599

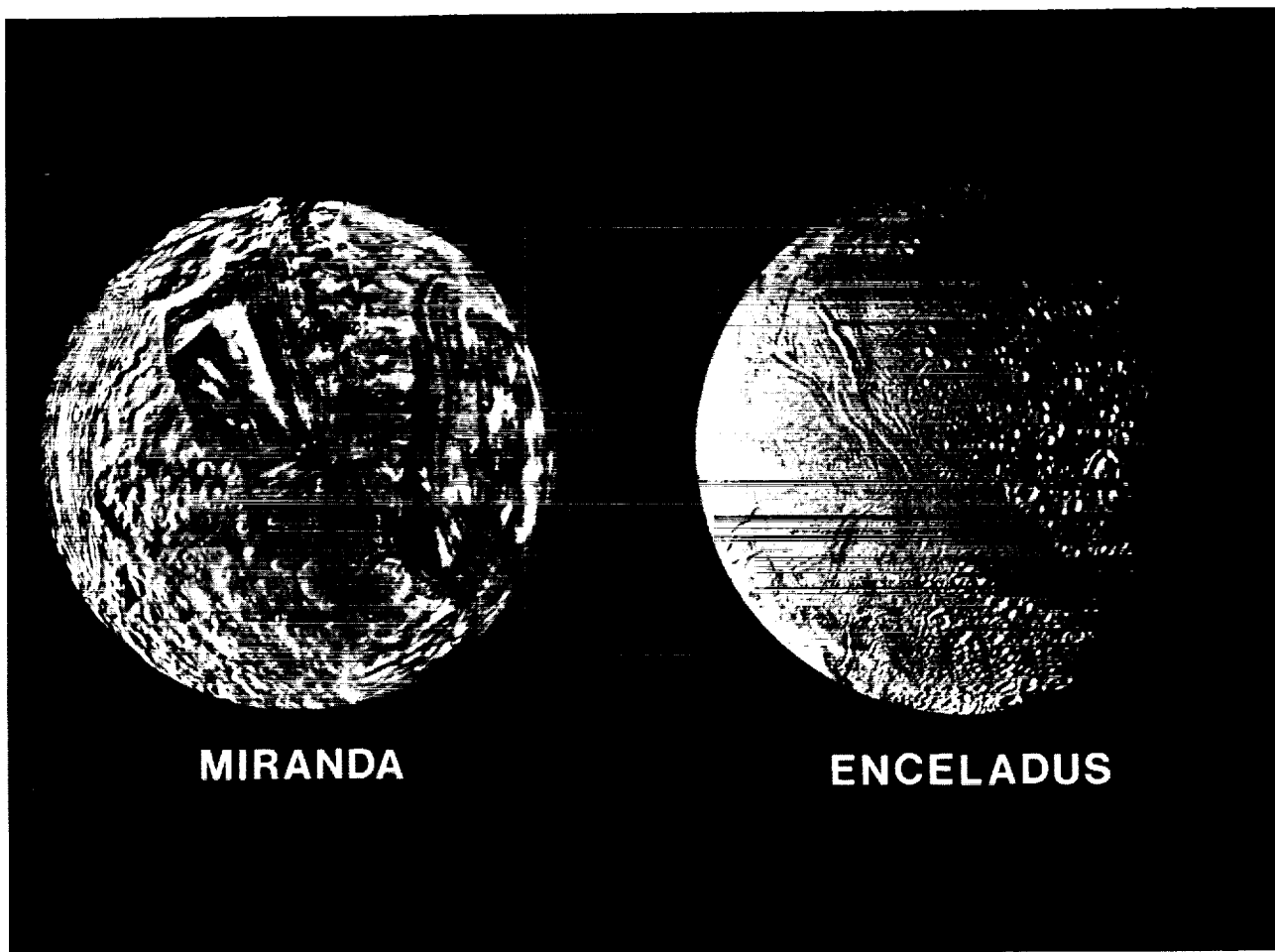
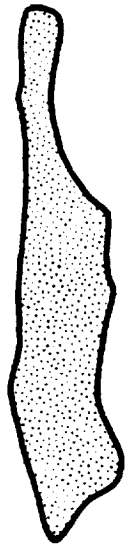


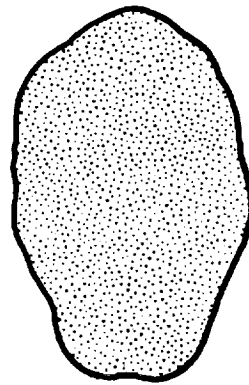
Photo 13 - ENCELADUS AND MIRANDA

88 H 373

ORIGINAL PAGE IS
OF POOR QUALITY



**MANHATTAN
ISLAND**



**NUCLEUS OF
HALLEY'S COMET**

Photo 14 - NUCLEUS OF HALLEY'S COMET AND MANHATTAN ISLAND

88 H 375

RINGED PLANET COMPARISONS

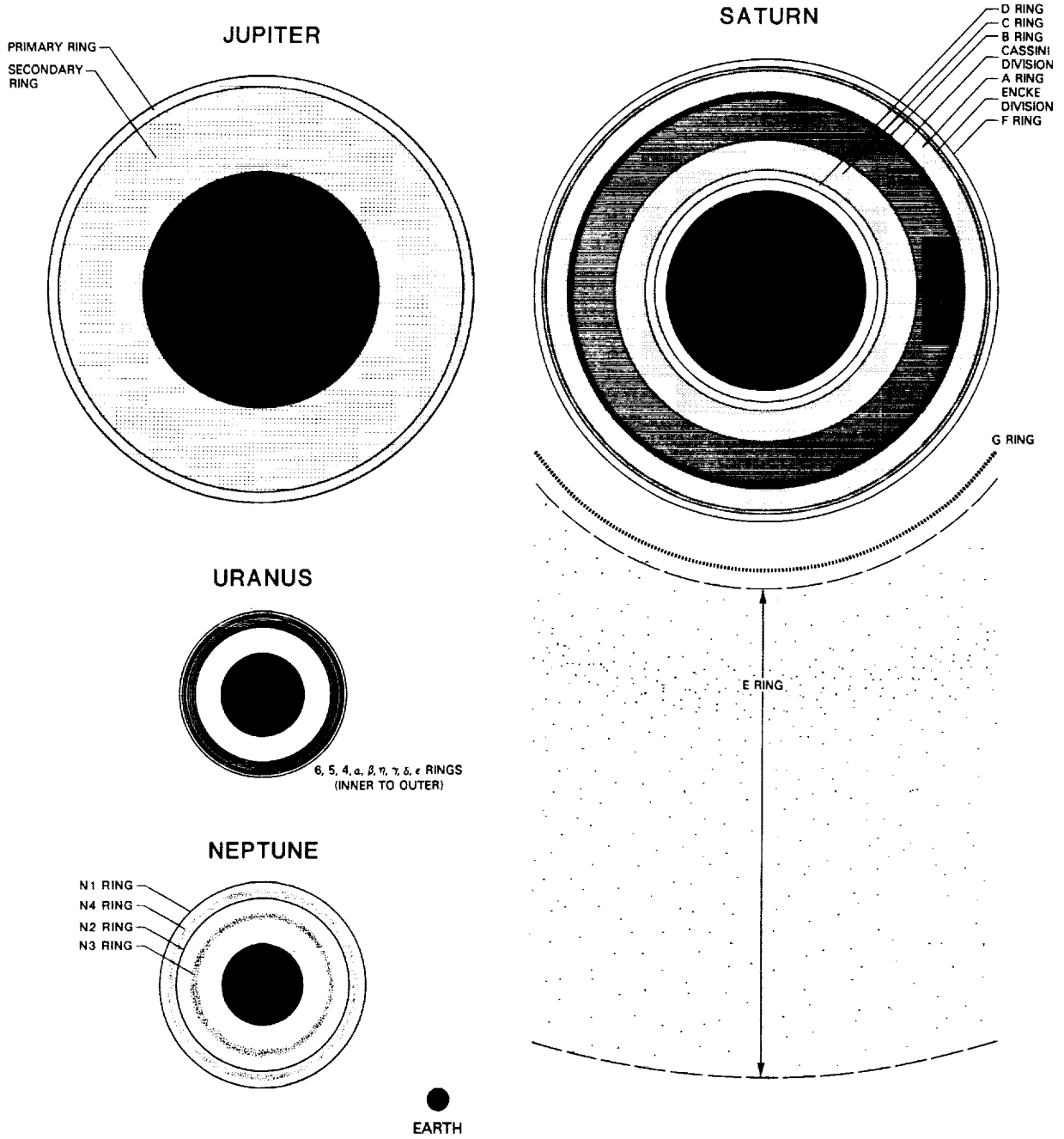


Photo 15 - RINGED PLANET COMPARISONS

90 H 600

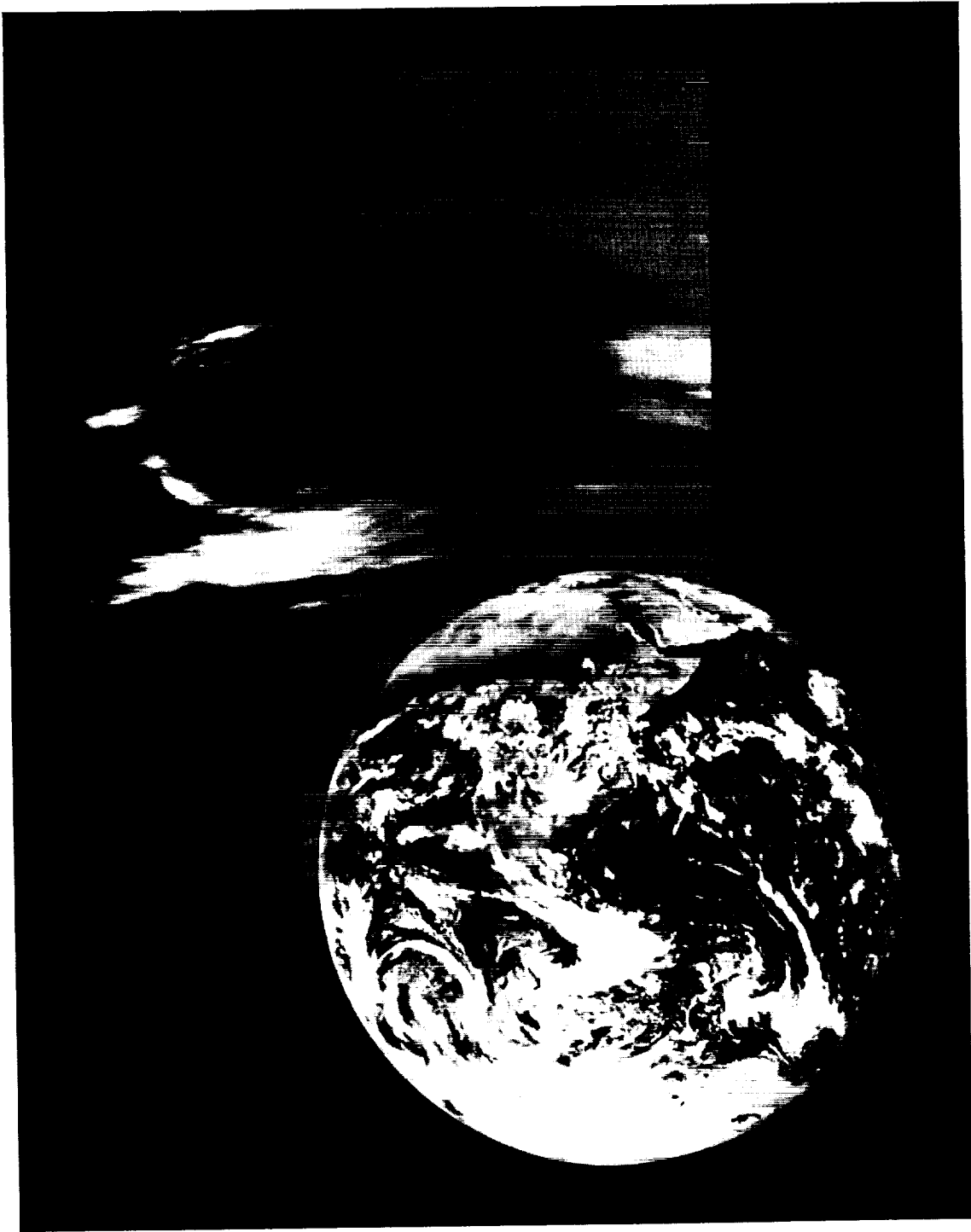


Photo 16- THE GREAT DARK SPOT

90 H 596
90 HC 548

SUGGESTED READING

- Batson, R., P. Bridges, and J. Inge, Atlas of Mars: U.S. Government Printing Office, Washington, D.C., 1979.
- Beatty, J.K., and A. Chaikin, The New Solar System (Third Edition): Sky Publishing Corporation, Cambridge, Mass. and Cambridge University Press, Cambridge, 1990.
- Briggs, V.G., and F. Taylor, The Cambridge Photographic Atlas of the Planets: Cambridge University Press, New York, 1982.
- Burgess, E., To The Red Planet: Columbia University Press, New York, 1978.
- Carr, M.H., The Surface of Mars: Yale University Press, New Haven, Connecticut, 1981.
- Carr, M.H. (Ed.), et al., The Geology of the Terrestrial Planets: (NASA SP-469), U.S. Government Printing Office, Washington D.C., 1984.
- Cortright, E., Apollo Expeditions to the Moon: (NASA SP-350), U.S. Government Printing Office, Washington, D.C., 1975.
- Davies, M., S. Dwornik, D. Gault, and R. Strom, Atlas of Mercury: (NASA SP-423), U.S. Government Printing Office, Washington, D.C., 1978.
- Dunne, J., and E. Burgess, The Voyage of Mariner 10: (NASA SP-424), U.S. Government Printing Office, Washington, D.C., 1978.
- Earth Photographs from Gemini III, IV, and V: (NASA SP-129), U.S. Government Printing Office, Washington, D.C., 1967.
- Earth Photographs from Gemini VI through XII: (NASA SP-171), U.S. Government Printing Office, Washington, D.C., 1968.
- The Far Planets: Time-Life Books, Inc., Richmond, Virginia, 1988.
- Fimmel, R., J. Van Allen, and E. Burgess, Pioneer: First to Jupiter, Saturn, and Beyond: (NASA SP-446), U.S. Government Printing Office, Washington, D.C., 1980.
- Greeley, R., Planetary Landscapes: Allen & Unwin, Boston, 1987.
- Guest, J., P. Butterworth, J. Murray, and W. O'Donnell, Planetary Geology: John Wiley & Sons, New York, 1979.
- Littman, M., Planets Beyond: John Wiley & Sons, New York, 1990.
- Lowman, P., Space Panorama: Weltflugbild, Zurich, Switzerland, 1968.
- Lowman, P., Lunar Panorama: Weltflugbild, Zurich, Switzerland, 1969.
- Masursky, H., G. Colton, F. El-Baz, et al., Apollo Over The Moon: A View From Orbit: (NASA SP-362), U.S. Government Printing Office, Washington, D.C., 1978.

- Meszaros, S.P., Photographic Catalog of Selected Planetary Size Comparisons: (NASA TM 86207), National Aeronautics and Space Administration/Goddard Space Flight Center, Greenbelt, Maryland, 1985. (Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.; Order Number: 033-000-00961-5).
- Meszaros, S.P., A Geographic Comparison of Selected Large-Scale Planetary Surface Features: (NASA TM 86147), National Aeronautics and Space Administration/Goddard Space Flight Center, Greenbelt, Maryland, 1984. (Available from the National Technical Information Service, Springfield, Virginia).
- Miller, R., and W. Hartmann, The Grand Tour--A Traveler's Guide to the Solar System: Workman Publishing, New York, 1981.
- Morrison, D., and J. Samz, Voyage to Jupiter: (NASA SP-439), U.S. Government Printing Office, Washington, D.C., 1980.
- Morrison, D., Voyages to Saturn: (NASA SP-451), U.S. Government Printing Office, Washington, D.C., 1982.
- Murray, B., and E. Burgess, Flight to Mercury: Columbia University Press, New York, 1977.
- Murray, B., M. Malin, and R. Greeley, Earthlike Planets: W. H. Freeman and Company, San Francisco, 1981.
- Mutch, T., et al., The Martian Landscape: (NASA SP-425), U. S. Government Printing Office, Washington, D.C., 1978.
- The Near Planets: Time-Life Books, Inc., Richmond, Virginia, 1989.
- Nicks, O., This Island Earth: (NASA SP-250), U.S. Government Printing Office, Washington, D.C., 1970.
- Short, N., P. Lowman, S. Freden, et al., Mission to Earth: Landsat Views the World: (NASA SP-360), U.S. Government Printing Office, Washington, D.C., 1976.
- Short, N., and R. Blair, (Eds.), et al., Geomorphology from Space: (NASA SP-486), U.S. Government Printing Office, Washington, D.C., 1986.
- Skylab Explores the Earth: (NASA SP-380), U.S. Government Printing Office, Washington, D.C., 1977.
- Spitzer, C. (Ed.), et al., Viking Orbiter Views of Mars: (NASA SP-441), U.S. Government Printing Office, Washington, D.C., 1980.
- Strom, R.G., Mercury: Smithsonian Institution Press, Washington, D.C., 1987.
- Washburn, M., Distant Encounters: The Exploration of Jupiter and Saturn: Harcourt Brace Jovanovich, New York, 1983.

1. Report No. NASA CR-4379		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Supplement to Photographic Catalog of Selected Planetary Size Comparisons				5. Report Date June 1991	
				6. Performing Organization Code	
7. Author(s) Stephen Paul Meszaros				8. Performing Organization Report No.	
9. Performing Organization Name and Address Department of Geology Arizona State University Tempe, AZ 85287				10. Work Unit No.	
				11. Contract or Grant No. NAGW-2102	
12. Sponsoring Agency Name and Address Office of Planetary Geosciences National Aeronautics and Space Administration Washington, DC 20546				13. Type of Report and Period Covered Contractor Report	
				14. Sponsoring Agency Code	
15. Supplementary Notes See NASA TM-86207					
16. Abstract This document updates and extends NASA Technical Memorandum 86207, "Photographic Catalog of Selected Planetary Size Comparisons," 1985. It utilizes photographs taken by NASA spacecraft to illustrate size comparisons of planets and moons of the solar system. Global views are depicted at the same scale, within each comparison, allowing size relationships to be studied visually.					
17. Key Words (Suggested by Author(s)) Planets and Moons Global Size Comparisons Planetary Photography				18. Distribution Statement Unclassified - Unlimited Subject Category 91	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 40	
				22. Price* A03	

